CLAIMS

1. An electronic component mounting method comprising:

forming a ball (96, 96a) at a tip of a metal wire (95) by an electric spark similarly to wire bonding and forming a bump (3, 103) by thermocompression-bonding the formed ball to an electrode (2) of an electronic component (1) with supersonic waves by means of a capillary (93, 193);

mounting the electronic component on a circuit board (4) by aligning in position the electrode of the electronic component with an electrode (5) of the board with interposition of an anisotropic conductive layer (10) in which an insulating resin mixed with an inorganic filler is mixed with a conductive particle (10a); and

subsequently bonding the electronic component to the circuit board by hardening the insulating resin of the anisotropic conductive layer interposed between the electronic component and the circuit board while correcting warp of the board and crushing the bump with a pressure force of not smaller than 20 gf per bump applied to the electronic component against the circuit board by means of a tool (8) and heat applied from the electronic component side or heat applied from the board side or heat applied from both the electronic component side and the board side,

so that the electrode of the electronic component is electrically connected with the electrode of the circuit board.

2. An electronic component mounting method as claimed in claim 1, wherein, before mounting the electronic component on the board by aligning in position the electrode of the electronic component with the electrode (5) of the circuit board (4) with interposition of the anisotropic conductive layer after the formation of the bump,

a tip of the formed bump is shaped so as to prevent collapse of a neck portion of the bump by once pressurizing the bump with a load of not greater than 20 gf.

3. An electronic component mounting method as claimed in claim 1 or 2, wherein

the insulating resin (6m) of the anisotropic conductive layer is an insulative thermosetting epoxy resin, and an amount of the inorganic filler mixed with this insulative thermosetting epoxy resin is 5 to 90 wt% of the insulative thermosetting epoxy resin.

4. An electronic component mounting method as claimed in any one of claims 1 through 3, wherein

the insulating resin (6m) of the anisotropic conductive layer is in a liquid form when applied to the board, and after semi-solidifying the resin by hardening

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the liquid of the applied insulating resin with the board placed in a furnace (503) or by pressurizing the liquid of the applied insulating resin by means of a heated tool (78) after the application to the board, the electronic component is mounted on the board.

5. An electronic component mounting method comprising:

forming a ball (96, 96a) at a tip of a metal wire (95) by an electric spark similarly to wire bonding and forming a gold bump (3, 103) by thermocompression-bonding the formed ball to an electrode (2) of an electronic component (1) with supersonic waves by means of a capillary (93, 193);

mounting the electronic component on a circuit board (4) by aligning in position the electrode of the electronic component with an electrode (5) of the board with interposition of an anisotropic conductive layer (10) in which an insulating resin mixed with an inorganic filler is mixed with a conductive particle (10a) without leveling the formed bump;

subsequently metallically bonding the gold bump to the electrode of the board with supersonic waves applied while shaping a tip so as to prevent collapse of a neck portion of the gold bump with a load applied from an upper surface side of the electronic component by means of a tool

(8); and

subsequently bonding the electronic component to the circuit board by hardening the insulating resin of the anisotropic conductive layer interposed between the electronic component and the circuit board while correcting warp of the board and crushing the bump with a pressure force of not smaller than 20 gf per bump applied to the electronic component against the circuit board and heat applied from the upper surface side of the electronic component or heat applied from the board side or heat applied from both the electronic component side and the board side, so that the electrode of the electronic component is electrically connected with the electrode of the circuit board.

6. An electronic component mounting method as claimed in any one of claims 1 through 5, wherein the electronic component (1) has a plurality of electrodes (2), a solid anisotropic conductive film sheet (10) that has a configurational dimension smaller than an outline dimension (OL) defined by joining the plurality of electrodes (2) of the electronic component (1) is stuck as the anisotropic conductive layer to the circuit board (4) before the positional alignment and thereafter subjected to the positional alignment, and at the bonding time, the insulating resin interposed between the electronic

component and the circuit board is hardened by pressurizing the electronic component against the circuit board with heat applied to the anisotropic conductive film sheet (10) while concurrently correcting the warp of the circuit board, so that the electronic component is bonded to the circuit board.

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7. An electronic component mounting method as claimed in any one of claims 1 through 6, wherein the gold bump that has an approximately conically shaped tip is formed on the electrode of the electronic component by means of the capillary that has a chamfer angle (θc) of not greater than 100° when a gold ball (96a) is formed by an electric spark at a tip of a gold wire (95) similarly to the wire bonding in forming the bump on the electronic component and a tip shape provided with no flat portion to be brought in contact with the gold ball.

8. An electronic component mounting method comprising:

forming a ball (96, 96a) at a tip of a metal wire (95) by an electric spark similarly to wire bonding and forming a bump (3, 103) on an electrode (2) of an electronic component (1) by means of a capillary (93, 193) by the formed ball;

mounting the electronic component on a circuit board (4) by aligning in position the electrode of the

electronic component with an electrode (5) of the board with interposition of an anisotropic conductive layer (10) in which an insulating resin mixed with an inorganic filler is mixed with a conductive particle (10a) without leveling the formed bump;

subsequently hardening the insulating resin of the anisotropic conductive layer interposed between the electronic component and the circuit board while correcting warp of the board with a pressure P1 applied as a pressure force to the electronic component against the circuit board and heat applied from an upper surface of the electronic component by means of a tool (8) heated to a specified temperature; and

subsequently bonding the electronic component to the circuit board while alleviating a stress when hardening the insulating resin of the anisotropic conductive layer by reducing the pressure force to a pressure P2 lower than the pressure P1 after a lapse of a specified time, so that the electrode of the electronic component is electrically connected with the electrode of the circuit board.

9. An electronic component mounting method as claimed in claim 8, wherein the pressure P1 is not smaller than 20 gf per bump, and the pressure P2 is not greater than one-half the pressure P1.

10. An electronic component mounting apparatus

comprising:

a device (7, 109, 200, 201) for sticking an anisotropic conductive layer (10), in which an insulating resin mixed with an inorganic filler is mixed with a conductive particle (10a), to an electrode (5) of a circuit board (4) or an electronic component (1);

a device (93, 193) for forming a bump (3, 103), without leveling, by forming a ball (96, 96a) by an electric spark at a tip of a metal wire (95) on an electrode (2) of the electronic component (1) similarly to wire bonding and forming by thermocompression-bonding this to the electrode of the board with supersonic waves by means of a capillary (93, 193);

a device (600) for mounting the electronic component on the electrode (5) of the circuit board (4) through positional alignment; and

a device (8, 9) for bonding the electronic component to the circuit board by hardening the insulating resin of the anisotropic conductive layer interposed between the electronic component and the circuit board while correcting warp of the board with a pressure force of not smaller than 20 gf per bump applied to the electronic component against the circuit board and with heating by means of the tool (8), so that the electrode of the electronic component is electrically connected with the

electrode of the circuit board.

11. An electronic component mounting apparatus comprising:

a device (7, 109, 200, 201) for sticking an anisotropic conductive layer (10), in which an insulating resin mixed with an inorganic filler is mixed with a conductive particle (10a), to an electrode (5) of a circuit board (4) or an electronic component (1);

a device (93, 193) for forming a gold bump (3, 103), without leveling, by forming a ball (96, 96a) by an electric spark at a tip of a metal wire (95) on an electrode (2) of the electronic component (1) similarly to wire bonding and forming by thermocompression-bonding this to the electrode of the board with supersonic waves by means of a capillary (93, 193);

a device (600) for mounting the electronic component on the electrode (5) of the circuit board (4) through positional alignment;

a device (620) for metallically bonding the gold bump to the electrode of the board with supersonic waves applied while shaping the tip so as to prevent collapse of a neck portion of the gold bump with a load applied from an upper surface of the electronic component by means of a tool (628); and

a device (8, 9) for bonding the electronic

component to the circuit board by hardening the insulating resin of the anisotropic conductive layer interposed between the electronic component and the circuit board while correcting warp of the board and crushing the bump with a pressure force of not smaller than 20 gf per bump applied to the electronic component against the circuit board with heating by means of the tool (8), so that the electrode of the electronic component is electrically connected with the electrode of the circuit board.

12. An electronic component mounting method as claimed in any one of claims 10 through 11, wherein

the device (93, 193) for forming the gold ball (96a) has the capillary, which has a tip shape provided with no flat portion to be brought in contact with the gold ball and of which a chamfer angle (θc) is not greater than 100°, and the gold bump that has an approximately conically shaped tip is formed on the electrode of the electronic component by the capillary.

13. An electronic component mounting apparatus comprising:

a device (7, 109, 200, 201) for sticking an anisotropic conductive layer (10), in which an insulating resin mixed with an inorganic filler is mixed with a conductive particle (10a), to a circuit board (4) or an electronic component (1);

a device (93, 193) for forming a bump (3, 103), without leveling, by forming a ball (96, 96a) by an electric spark at a tip of a metal wire (95) on an electrode (2) of the electronic component (1) similarly to wire bonding and forming this on the electrode of the board by means of a capillary (93, 193);

a device (600) for mounting the electronic component on the electrode (5) of the circuit board (4) through positional alignment; and

a device (8, 9) for hardening the insulating resin interposed between the electronic component and the circuit board while correcting warp of the board with a pressure P1 applied as a pressure force to the electronic component against the circuit board and heat applied from an upper surface of the electronic component by means of a tool (8) heated to a specified temperature and subsequently bonding the electronic component to the circuit board while alleviating a stress caused when hardening the insulating resin of the anisotropic conductive layer by reducing the pressure force to a pressure P2 lower than the pressure P1 after a lapse of a specified time, so that the electrode of the electronic component is electrically connected with the electrode of the circuit board.

14. An electronic component mounting method as claimed in any one of claims 1 through 3, wherein a mean

particle diameter of the inorganic filler mixed with the insulating resin of the anisotropic conductive layer is not smaller than 3 μm.

15. An electronic component mounting method as claimed in any one of claims 1 through 3 and 14, wherein the inorganic filler mixed with the insulating resin of the anisotropic conductive layer is comprised of at least two types of inorganic fillers (6f-1, 6f-2) that have a plurality of different mean particle diameters, and a mean particle diameter of one inorganic filler (6f-1) out of at least two types of inorganic fillers is not less than two times different from a mean particle diameter of the other inorganic filler (6f-2) out of at least two types of inorganic fillers.

16. An electronic component mounting method as claimed in any one of claims 1 through 3, 14 and 15, wherein the anisotropic conductive layer has a portion brought in contact with either the electronic component or the board, the portion having a smaller amount of inorganic filler than that of the other portion.

17. An electronic component mounting method as claimed in claim 15, wherein the anisotropic conductive layer has a portion brought in contact with both the electronic component and the board, the portion having a smaller amount of inorganic filler than that of the other

portion.

18. An electronic component unit, wherein an electrode (2) of an electronic component (1) is electrically connected to an electrode (5) of a circuit board (4) with a bump (3, 103) formed on the electrode (2) of the electronic component (1) and bonded to the electrode (5) of the circuit board (4) in a state in which the bump is crushed with interposition of an anisotropic conductive layer (10), in which an insulating resin (6m) is mixed with an inorganic filler (6f) and hardened, and

the anisotropic conductive layer (10) has a portion brought in contact with either the electronic component or the board, the portion having a smaller amount of inorganic filler than that of the other portion.

19. An electronic component unit, wherein an electrode (2) of an electronic component (1) is electrically connected to an electrode (5) of a circuit board (4) with a bump (3, 103) formed on the electrode (2) of the electronic component (1) and bonded to the electrode (5) of the circuit board (4) in a state in which the bump is crushed with interposition of an anisotropic conductive layer (10), in which an insulating resin (6m) is mixed with an inorganic filler (6f) and hardened, and

the anisotropic conductive layer (10) comprises: a first resin layer (6x), which is positioned in a portion

brought in contact with either the electronic component or the board and in which an insulating resin identical to the insulating resin is mixed with the inorganic filler; and a second resin layer (6y), which is in contact with the first resin layer and is made of an insulating resin whose amount of the inorganic filler is less than that of the first resin layer.

20. An electronic component mounting method as claimed in any one of claims 1 through 9, and 14 through 17, wherein the bump is a bump formed by plating or printing.

21. An electronic component unit as claimed in any one of claims 18 through 19, wherein the bump is a bump formed by plating or printing.

22. An electronic component mounting method as claimed in any one of claims 1 through 9, 14 through 17 and 20, wherein the anisotropic conductive layer is provided by mixing the solid insulating resin mixed with the inorganic filler with a conductive particle (10a) that has a mean diameter greater than a mean particle diameter of the inorganic filler.

23. An electronic component mounting apparatus as claimed in any one of claims 10 through 12, wherein the anisotropic conductive layer is provided by mixing the solid insulating resin mixed with the inorganic filler (6f) with a conductive particle (10a) that has a mean diameter

greater than a mean particle diameter of the inorganic filler.

24. An electronic component unit as claimed in any one of claims 18 through 19 and 21, wherein the anisotropic conductive layer is provided by mixing the solid insulating resin mixed with the inorganic filler (6f) with a conductive particle (10a) that has a mean diameter greater than a mean particle diameter of the inorganic filler.

25. An electronic component mounting method comprising:

forming a ball (96, 96a) at a tip of a metal wire (95) by an electric spark similarly to wire bonding and forming a bump (3, 103) by thermocompression-bonding the formed ball to an electrode (2) of an electronic component (1) with supersonic waves by means of a capillary (93, 193);

mounting the electronic component on a circuit board (4) while aligning in position the electrode of the electronic component with an electrode (5) of the board with interposition of a solid or semi-solid insulating resin layer (6, 306b) in which an insulating resin (306m) is mixed with an inorganic filler (6f) without leveling the formed bump; and

subsequently bonding the electronic component to the circuit board by hardening the insulating resin layer

interposed between the electronic component and the circuit board while correcting warp of the board and crushing the bump with a pressure force of not smaller than 20 gf per bump applied to the electronic component against the circuit board by means of a tool (8) and heat applied from the electronic component side or heat applied from the board side or heat applied from both the electronic component side and the board side, so that the electrode of the electronic component is electrically connected with the electrode of electrically connected the circuit board.

26. An electronic component mounting method as claimed in claim 25, wherein, before mounting the electronic component on the board while aligning in position the electrode of the electronic component with the electrode (5) of the circuit board (4) with interposition of the solid or semi-solid insulating resin layer (6, 306b) in which the insulating resin (306m) is mixed with the inorganic filler (6f) after the formation of the bump,

a tip of the formed bump is shaped so as to prevent collapse of a neck portion of the bump by once pressurizing the bump with a load of not greater than 20 gf.

27. An electronic component mounting method as claimed in claim 25 or 26, wherein

the insulating resin (306m) is an insulative thermosetting epoxy resin, and an amount of the inorganic

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filler mixed with this insulative thermosetting epoxy resin is 5 to 90 wt% of the insulative thermosetting epoxy resin.

28. An electronic component mounting method comprising:

forming a ball (96, 96a) at a tip of a metal wire (95) by an electric spark similarly to wire bonding and forming a gold bump (3, 103) by thermocompression-bonding the formed ball to an electrode (2) of an electronic component (1) with supersonic waves by means of a capillary (93, 193);

mounting the electronic component on a circuit board (4) while aligning in position the electrode of the electronic component with an electrode (5) of the board with interposition of a solid or semi-solid insulating resin layer (6, 306b) in which an insulating resin (306m) is mixed with an inorganic filler (6f) without leveling the formed bump;

subsequently metallically bonding the gold bump to the electrode of the board with supersonic waves applied while shaping the tip so as to prevent collapse of a neck portion of the gold bump with a load applied from an upper surface side of the electronic component by means of a tool (8); and

subsequently bonding the electronic component to the circuit board by hardening the insulating resin

interposed between the electronic component and the circuit board while correcting warp of the board and crushing the bump with a pressure force of not smaller than 20 gf per bump applied to the electronic component against the circuit board and heat applied from the upper surface side of the electronic component or heat applied from the board side or heat applied from both the electronic component side and the board side, so that the electrode of the electronic component is electrically connected with the electrode of the circuit board.

29. An electronic component mounting method as claimed in any one of claims 25 through 28, wherein the electronic component (1) has a plurality of electrodes (2), a solid insulating resin sheet (6) that has a configurational dimension smaller than an outline dimension (OL) defined by joining the plurality of electrodes (2) of the electronic component (1) is stuck as the insulating resin layer to the circuit board (4) before the positional alignment and thereafter subjected to the positional alignment, and at the bonding time, the insulating resin interposed between the electronic component and the circuit board is hardened while concurrently correcting the warp of the circuit board by pressurizing the electronic component against the circuit board with heat applied to the insulating resin sheet (6), so that the electronic

component is bonded to the circuit board.

30. An electronic component mounting method as claimed in any one of claims 25 through 29, wherein the gold bump that has an approximately conically shaped tip is formed on the electrode of the electronic component by means of the capillary that has a chamfer angle (θc) of not greater than 100° when a gold ball (96a) is formed by an electric spark at a tip of a gold wire (95) similarly to the wire bonding in forming the bump on the electronic component and a tip shape provided with no flat portion to be brought in contact with the gold ball.

31. An electronic component mounting method comprising:

forming a ball (96, 96a) at a tip of a metal wire (95) by an electric spark similarly to wire bonding and forming a bump (3, 103) on an electrode (2) of an electronic component (1) by means of a capillary (93, 193) by the formed ball;

mounting the electronic component on a circuit board (4) while aligning in position the electrode of the electronic component with an electrode (5) of the board with interposition of a solid or semi-solid insulating resin layer (6, 306b) in which an insulating resin (306m) is mixed with an inorganic filler (6f) without leveling the formed bump;

subsequently hardening the insulating resin interposed between the electronic component and the circuit board while correcting warp of the board with a pressure P1 applied as a pressure force to the electronic component against the circuit board and heat applied from an upper surface of the electronic component by means of a tool (8) heated to a specified temperature; and

subsequently bonding the electronic component to the circuit board while alleviating a stress caused when hardening the insulating resin by reducing the pressure force to a pressure P2 lower than the pressure P1 after a lapse of a specified time, so that the electrode of the electronic component is electrically connected with the electrode of the circuit board.

32. An electronic component mounting method as claimed in claim 31, wherein the pressure P1 is not smaller than 20 gf per bump, and the pressure P2 is not greater than one-half the pressure P1.

33. An electronic component mounting apparatus comprising:

a device (7, 109, 200, 201) for sticking a solid or semi-solid insulating resin layer (6, 306b), in which an insulating resin (306m) is mixed with an inorganic filler (6f), to an electrode (5) of a circuit board (4) or an electronic component (1);

a device (93, 193) for forming a bump (3, 103), without leveling, by forming a ball (96, 96a) by an electric spark at a tip of a metal wire (95) on an electrode (2) of the electronic component (1) similarly to wire bonding and forming by thermocompression-bonding this to the electrode of the board with supersonic waves by means of a capillary (93, 193);

a device (600) for mounting the electronic component on the electrode (5) of the circuit board (4) through positional alignment; and

a device (8, 9) for bonding the electronic component to the circuit board by hardening the insulating resin interposed between the electronic component and the circuit board while correcting warp of the board with a pressure force of not smaller than 20 gf per bump applied to the electronic component against the circuit board with heating by means of the tool (8), electrically connecting the electrode of the electronic component with the electrode of the circuit board.

34. An electronic component mounting apparatus comprising:

a device (7, 109, 200, 201) for sticking a solid or semi-solid insulating resin layer (6, 306b), in which an insulating resin (306m) is mixed with an inorganic filler (6f), to an electrode (5) of a circuit board (4) or an

electronic component (1);

a device (93, 193) for forming a gold bump (3, 103), without leveling, by forming a ball (96, 96a) by an electric spark at a tip of a metal wire (95) on an electrode (2) of the electronic component (1) similarly to wire bonding and forming by thermocompression-bonding this to the electrode of the board with supersonic waves by means of a capillary (93, 193);

a device (600) for mounting the electronic component on the electrode (5) of the circuit board (4) through positional alignment;

a device (620) for metallically bonding the gold bump to the electrode of the board with supersonic waves applied while shaping the tip so as to prevent collapse of a neck portion of the gold bump with a load applied from an upper surface of the electronic component by means of a tool (628); and

a device (8, 9) for bonding the electronic component to the circuit board by hardening the insulating resin interposed between the electronic component and the circuit board while correcting warp of the board and crushing the bump with a pressure force of not smaller than 20 gf per bump applied to the electronic component against the circuit board with heating by means of the tool (8), so that the electrode of the electronic component is

electrically connected with the electrode of the circuit board.

35. An electronic component mounting apparatus comprising:

a device (7, 109, 200, 201) for sticking a solid or semi-solid insulating resin layer (6, 306b), in which an insulating resin (306m) is mixed with an inorganic filler (6f), to a circuit board (4) or an electronic component (1);

a device (93, 193) for forming a bump (3, 103), without leveling, by forming a ball (96, 96a) by an electric spark at a tip of a metal wire (95) on an electrode (2) of the electronic component (1) similarly to wire bonding and forming this on the electrode of the board by means of a capillary (93, 193);

a device (600) for mounting the electronic component on the electrode (5) of the circuit board (4) through positional alignment; and

a device (8, 9) for hardening the insulating resin interposed between the electronic component and the circuit board while correcting warp of the board with a pressure P1 applied as a pressure force to the electronic component against the circuit board and heat applied from an upper surface of the electronic component by means of a tool (8) heated to a specified temperature and subsequently

bonding the electronic component to the circuit board while alleviating a stress caused when hardening the insulating resin by reducing the pressure force to a pressure P2 lower than the pressure P1 after a lapse of a specified time, so that the electrode of the electronic component is electrically connected with the electrode of the circuit board.

36. An electronic component mounting method as claimed in any one of claims 25 through 27, wherein the inorganic filler mixed with the insulating resin is provided by a plurality of types of inorganic fillers (6f-1, 6f-2), which have different mean particle diameters.

37. An electronic component mounting method as claimed in any one of claims 25 through 27 and 36, wherein the insulating resin layer (6, 306b) has a portion brought in contact with either the electronic component or the board, the portion having a smaller amount of inorganic filler than that of the other portion.

38. An electronic component mounting method as claimed in claim 37, wherein the insulating resin layer (6, 306b) has a portion brought in contact with both the electronic component and the board, the portion having a smaller amount of inorganic filler than that of the other portion.

39. An electronic component mounting method as

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claimed in claim 37 or 38, wherein the portion brought in contact with the electronic component is provided by an insulating resin that improves adhesion to a film material used on a surface of the electronic component, and the portion brought in contact with the board is provided by an insulating resin that improves adhesion to a material used on a surface of the board.

40. An electronic component mounting method as claimed in any one of claims 25 through 27 and 36, wherein the insulating resin layer (6, 306b) has a portion brought in contact with either the electronic component or the board, the portion being mixed with no inorganic filler.

41. An electronic component unit, wherein an electrode (2) of an electronic component (1) is electrically connected to an electrode (5) of a circuit board (4) with a bump (3, 103) formed on the electrode (2) of the electronic component (1) and bonded to the electrode (5) of the circuit board (4) in a state in which the bump is crushed with interposition of an insulating resin layer (6, 306b), in which an insulating resin (306m) is mixed with an inorganic filler (6f) and hardened, and

the insulating resin layer (6, 306b) has a portion brought in contact with either the electronic component or the board, the portion having a smaller amount of inorganic filler than that of the other portion.

42. An electronic component unit, wherein an electrode (2) of an electronic component (1) is electrically connected to an electrode (5) of a circuit board (4) with a bump (3, 103) formed on the electrode (2) of the electronic component (1) and bonded to the electrode (5) of the circuit board (4) in a state in which the bump is crushed with interposition of an insulating resin layer (6, 306b), in which an insulating resin (306m) is mixed with an inorganic filler (6f) and hardened, and

the insulating resin layer (6, 306b) comprises: a first resin layer (6x), which is positioned in a portion brought in contact with either the electronic component or the board and in which an insulating resin identical to the insulating resin is mixed with the inorganic filler; and a second resin layer (6y), which is in contact with the first resin layer and is made of an insulating resin whose amount of the inorganic filler is less than that of the first resin layer.

43. An electronic component mounting method as claimed in claim 5 or 28, wherein heating is effected from the upper surface side of the electronic component or from the board side or from both the electronic component side and the board side when metallically bonding the gold bump to the electrode of the board with supersonic waves applied.

44. An electronic component unit, wherein the

electronic component is mounted on the board by the electronic component mounting method claimed in any one of claims 1 through 9, 14 through 17, 25 through 32, 36 through 40 and 43.

45. An electronic component mounting apparatus as claimed in claim 11 or 34, wherein the apparatus for metallically bonding the gold bump to the electrode of the board with supersonic waves applied comprises a heating member for effecting heating from the upper surface side of the electronic component or from the board side or from both the electronic component side and the board side, and the heating is effected by the heating member at a time of metallic bonding.

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